

Short Report



A New Proposal for Crossing Two or More Sheaths through Single Trans-Septal Puncture in Ablation of Atrial Fibrillation: Experience with Steerable Introducer

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Introduction: We have sometimes experienced difficulty in crossing two or more sheath through one septal puncture for catheter based pulmonary vein isolation.

Methods: Subjects were 32 consecutive patients (25 men and 7 women) ranging from age 43 to 76 with paroxysmal or sustained atrial fibrillation, who underwent extensive pulmonary vein isolation. After the Brockenbrough puncture using a Daig SL0 dilator sheath system, the sheath dilator was pulled back into the right atrium leaving the 0.035 inch guide wire in the left atrium. In the initial 19 patients, we attempted to put the second Daig SL0 sheath in the left atrium using the electrode catheter. In the 13 subsequent patients, we used the SL0 sheath dilator in 6 and a newly developed steerable introducer in 7 patients. The sheath dilator was aligned with the anchored first guide wire under the guidance of biplane fluoroscopy. After advancing the second dilator system in the left atrium, the system was pulled back leaving the second guide wire in the left atrium. The third sheath system was positioned in the same manner.

Results: In the two of the 19 conventional cases, the second sheath with electrode did not pass the septum and needed another Brockenbrough puncture. In the 13 subsequent cases using the new method, the sheath dilator systems were successfully positioned in all cases with no major complications. The steerable sheath was very useful for aiming at the puncture site.

In conclusion, the new technique was very useful and simple for crossing two or more sheaths through a single trans-septal puncture.
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Key words: Catheter ablation, Atrial fibrillation, Steerable sheath, Brockenbrough method

Radiofrequency catheter ablation for patients with paroxysmal or sustained atrial fibrillation has developed over time.^{1–12)} The pulmonary veins have been

used effectively in catheter ablation. We can place the electrode catheter in the left atrium and the pulmonary veins using a transseptal puncture with a

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Brockenbrough needle.¹³⁾ To accomplish pulmonary vein isolation using ablation and circular mapping electrode catheters, we need to place two or more transseptal sheaths in the left atrium.⁷⁻⁹⁾ Several methods have been used for positioning two or more transseptal sheaths.¹²⁾ One is a multiple transseptal puncture method using a Brockenbrough needle. Another is a single transseptal puncture followed by a multiple sheath put in a single hole at the fossa ovalis. Theoretically, multiple punctures could increase risk, by causing cardiac tamponade, for example. When we insert the second sheath through a single transseptal puncture, we have used an electrode catheter for the second sheath and aligned it under fluoroscopic guidance with a guidewire anchored earlier, and advanced the electrode catheter and sheath system into the left atrium. Fagundes et al. reported the safety and clinical usefulness of a single transseptal puncture.¹²⁾ However, in a description by Yamada the second electrode could not be always crossed easily through the atrial septum, because the opening of the puncture site is too small for the electrode to pass.¹⁴⁾ Therefore, we newly developed a simple method for crossing the second sheath using the sheath dilator system. Moreover, the usefulness of a newly-developed steerable sheath was examined for crossing the interatrial septum.

Methods

Subjects were 32 consecutive patients (25 men and 7 women) ranging from age 43 to 76 who underwent extensive pulmonary vein isolation by radiofrequency catheter ablation in our hospital from January 2007 to August 2009. Twenty-one patients had paroxysmal atrial fibrillation and 11 had sustained atrial fibrillation. All patients provided written informed consent. In all patients 3D-CT of the left atrium and pulmonary veins was performed before ablation and the structure and size of the pulmonary veins were confirmed. Trans-esophageal echocardiography was also performed before ablation, and the left atrial function and the presence or absence of thrombus were examined. Extensive pulmonary vein isolation was performed according to the Takahashi's method.⁵⁾ Prior to ablation, anticoagulation therapy was performed in the out-patient clinic, keeping PT-INR between 1.5 and 2.0. One 6F sheath was inserted via the right subclavian or jugular vein and an electrode catheter was advanced into the coronary sinus.

In the initial 25 patients three 8F sheaths (Fast-Cath™ Swartz™ SL0, St. Jude Medical, St Paul,

MN, USA) were used as transseptal sheaths via the right femoral vein, and in the subsequent 7 patients two SL0 sheaths and one newly developed 8.5F steerable introducer (Agilis NXT, ST. Jude, Medical, St Paul, MN, USA) were used. Transseptal puncture was performed via the conventional approach for access to the left atrium.¹³⁾ The dilator sheath SL0 system was inserted from the right femoral vein and was advanced under fluoroscopic guidance into the superior vena cava over a 0.035 inch guidewire belonging to the sheath set. Then, the guidewire was pulled out and flushed with a saline and heparin (10 U/ml) solution and replaced with a Brockenbrough needle. The transseptal assembly was then withdrawn caudally keeping the needle hub arrow rotated backward between 4 and 5 o'clock until the tip engaged the fossa ovalis. We pushed the needle gently into the inter-atrial septum. We confirmed that the needle tip was in the left atrium by arterial blood incubation and injection with contrast medium of 1.5–2 ml. Thereafter, the whole sheath system was advanced very carefully by 2–3 cm into the left atrium. Then, the Brockenbrough needle was replaced by the 0.035 inch guide wire belonging to the sheath set and the SL0 dilator sheath system was advanced further in the left atrium. Then, a heparin bolus (5,000–7,000 U) was administered and continuous infusion of heparin at a rate of 1,000 U/hr was started. The rate of heparin infusion was adjusted, maintaining activated clotting time (ACT) value between 250" and 350". The first SL0 dilator sheath system was pulled back to the right atrium and only the guide-wire was left and anchored in the left superior pulmonary vein or left atrium (**Figure 1**). Next, in the initial 19 of the 32 patients, an 8F ablation electrode catheter in another SL0 sheath was used for crossing the septum. In the subsequent 13 patients, the SL0 dilator sheath in 6 patients, or a newly developed steerable introducer (Agilis NXT) in 7 patients, was used for crossing the septum. We conducted the tip of the electrode or the sheath dilator to the first puncture site of the fossa ovalis, withdrawing caudally in a Brockenbrough technique-like manner, referring to the prior-positioned 0.035-inch guidewire in the left atrium under the guidance of biplane fluoroscopy of frontal and 60° left anterior oblique projections (**Figure 2**). After confirming the alignment of the anchored guidewire and the second sheath dilator system at the first puncture site, the electrode or dilator sheath was advanced very slowly into the left atrium. We did not feel any resistance at all when we advanced the sheath. After the sheath dilator crossed the septum, the 0.035-inch guide wire was advanced to the

pulmonary veins or the left atrium, and then the sheath-dilator system was advanced further. The second sheath system was also pulled back to the right atrium, leaving the guide wire in the left atrium or pulmonary vein. The third SL0 system was advanced and inserted into the left atrium in the same manner (**Figure 3**). Finally, the first and second sheath dilator systems were advanced over the guidewire anchored in the left atrium. One of the two SL0 sheaths was used for a circular mapping catheter (Lasso) in the upper pulmonary vein and the steerable introducer was used for mapping of the lower pulmonary vein (**Figure 4**). The remaining SL0 sheath in the left atrium was used for ablation to accomplish pulmonary vein isolation.

Results

In two of the 19 initial patients, the ablation electrode catheter did not cross the septum and we could not place the SL0 sheath in the left atrium requiring a second Brockenbrough puncture. In the subsequent 13 cases using a sheath dilator, we successfully advanced three sheath systems to the left atrium through a single transseptal puncture (**Table**). However, the difference in the success rate between the two methods was not statistically significant. When we aimed at the first puncture site, the steerable introducer was easier to handle than the SL0 sheath system. In all cases the electrode catheter was properly maneuvered at the PV ostium.

Figure 1

After the Brockenbrough maneuver was completed, the needle was replaced with the 0.035-inch guidewire belonging to the sheath set and the SL0 dilator sheath system was advanced in the left atrium. The SL0 dilator sheath system was pulled back to the right atrium and only the guidewire (arrow) was left and was anchored in the left superior pulmonary vein. The second dilator sheath system (arrow) was advanced in the right atrium over the guidewire.

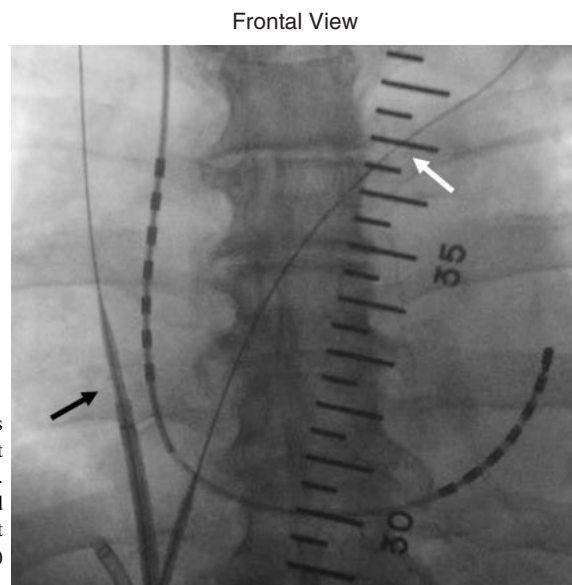
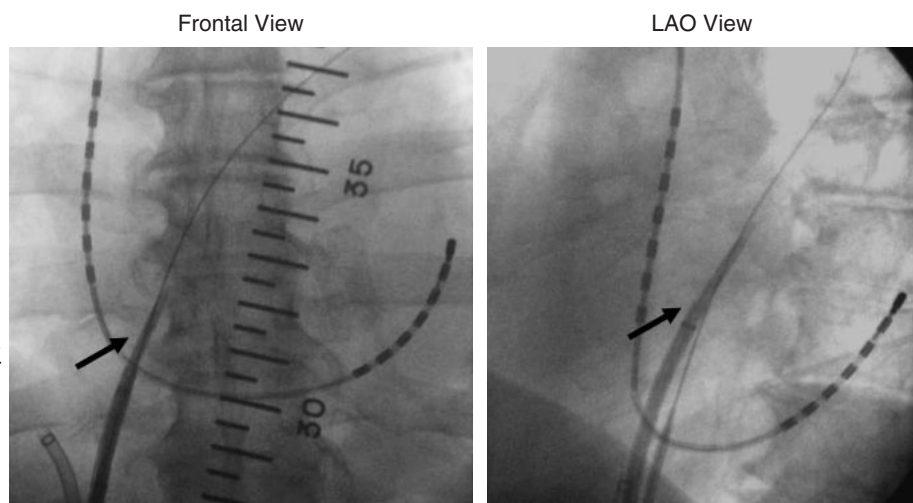
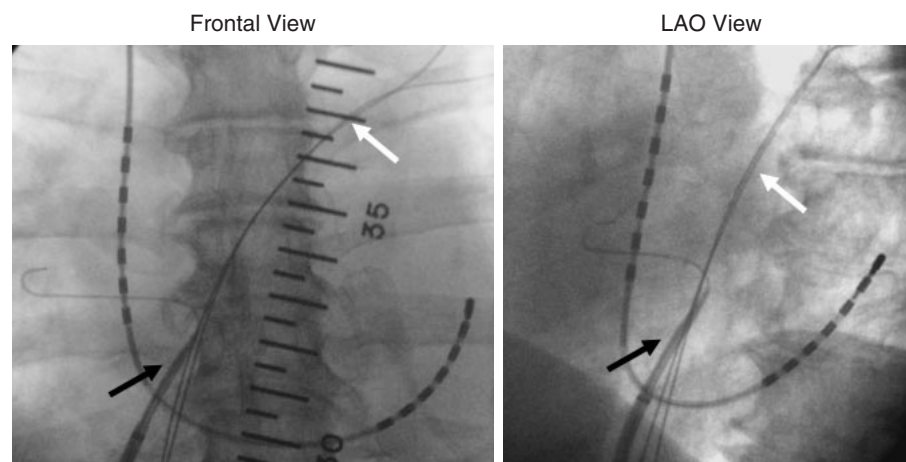


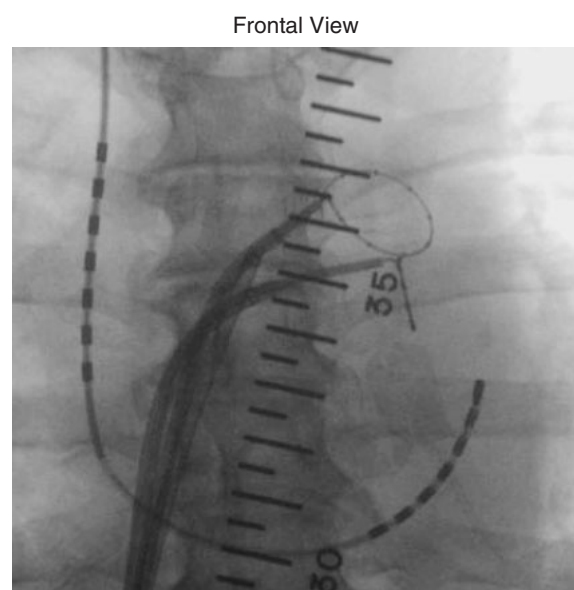
Figure 2

The tip of the dilator sheath system (Steerable sheath dilator or SL0) was conducted at the first puncture site of the fossa ovalis, referring to the prior-positioned 0.035-inch guide wire in the left atrium under biplane fluoroscopic guidance.



**Figure 3**

The third SL0 system was aligned with two prior-anchored guidewires by the same maneuver.

**Figure 4**

Three sheaths were positioned in the left atrium. The one of the two SL0 sheaths was used for a circular mapping catheter (Lasso) in the upper pulmonary vein and the steerable introducer was used for mapping of the lower pulmonary vein.

None of the 13 subsequent cases had major complications such as cerebral infarction, thrombo-embolism and cardiac tamponade, while one pericardial effusion and one air embolism to the right coronary artery occurred among the 19 initial patients.

Discussion

The transseptal puncture system was developed by Ross for measurement of left atrial pressure.¹³⁾ The technique has been performed in catheter ablation procedures such as left side accessory pathway, left

Table Comparison of success rate of positioning the three sheaths in the left atrium through one septal puncture

	Success	Failure
Conventional method (19)	17	2
New sheath method (13)	13	0

P = 0.513 (Fisher's test)

atrial tachycardias, and atrial fibrillation.¹⁵⁾ When we perform extensive pulmonary vein isolation using an ablation catheter in patients with atrial fibrillation, we need one electrode catheter for ablation and one or two circular electrode catheters for mapping of the pulmonary veins.⁷⁾ Therefore, two or three transseptal sheaths are needed. When two or more separate transseptal punctures are performed, the patients are not fully heparinized until completion of the second or third transseptal puncture. This delay of heparin administration may allow thrombus formation on the first puncture site or catheter. Daoud described the technique of transseptal catheterization guided by intracardiac echocardiogram, referring to the potential risk of thrombo-embolic complications secondary to the presence of a guidewire in the left atrium for more than 1 minute.¹⁶⁾ Intracardiac echocardiography showed common occurrence of thrombosis in transseptal punctures.^{17,18)} In these studies, the incidence of clot formation in the transseptal sheath was 8–9%. Instead of multiple septal puncture, the second or third sheaths have been usually inserted using an electrode catheter and sheath. Fangundes found that a second transseptal puncture was required in only 6 of 1,150 (0.5%) cases using a one-septal puncture method.¹²⁾ However, Yamada found that the transseptal manoeuvre using an electrode catheter for the transseptal insertion of a second sheath was unsuccessful in

7% of the patients because of the smallness of the transseptal puncture hole.¹⁵⁾ We failed to cross the second electrode and sheath system even when we used an additional stiff electrode catheter in two of the 19 initial patients (10%). The success rate of crossing the electrode may depend on the fragility of the inter-atrial septum and the stiffness of the electrode. Yamada et al. attempted three different techniques to achieve one-puncture, double-transseptal catheterization. In the first technique, two guidewires were introduced into the first transseptal sheath. After the transseptal sheath was removed, two transseptal sheaths were introduced into the left atrium via the femoral vein over the two guidewires, respectively. In the second technique, the transseptal sheath was replaced by a dilator of a 12F transseptal sheath, and the transseptal puncture hole was enlarged. However, those two maneuvers may cause frequent bleeding at the femoral vein puncture site. In the third technique, the deflected ablation catheter was pulled down in order to extend the trans-septal puncture hole. They found the last maneuver was successful without any complications in all seven patients. However, we are concerned about the large tear created in the inter-atrial septum and persistent large atrial septal defect caused by their last method. Therefore, we developed this new sheath-dilator method for positioning multiple sheaths in the left atrium through one septal puncture. We were successfully positioned three sheaths in the one septal hole in all 13 patients. The newly available steerable sheath was especially useful for aligning the prior-positioned guidewire as compared with the conventional sheath dilator system. Recently, Rajappan K et al. mentioned a learning curve and were concerned about the merit of the steerable sheath. After correcting for the learning curve, CT registration time and right PV isolation was quicker in their steerable sheath group. Our method using one septal puncture is beneficial for avoiding any additional risk in performing the Brockenbrough puncture. We also do not require a second septal hole nor do we need an additional electrode catheter for crossing the septum. The steerable sheath may be very useful as a second sheath, but it is more expensive than the conventional sheath. We did not find the steerable sheath useful as a third sheath system because at 8.5F it was larger than the SLO sheath. By means of using the guidewire and with careful observation under biplane fluoroscopy, the sheath dilator system did not cause any harm to the heart and vessels. No complications such as thrombo-embolism, perforation of the heart chambers or cardiac tamponade occurred in our procedure.

However, one septal puncture with three sheaths may result in a larger septal defect than multiple septal puncture with one sheath in each puncture site. It was found that persistent atrial septal defect was detected by transesophageal echocardiography in 2 of 31 patients several months after pulmonary vein isolation even with a double transseptal puncture.¹⁹⁾ Clinical significance of the iatrogenic persistent atrial septal defect should be further studied.

Implication

The sheath dilator method was an economically low-cost and alternative technique for positioning promptly multiple sheaths in the left atrium through one puncture and the newly available steerable sheath may allow the a greater advantage for this method.

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